

WHAT IS CLAIMED IS:

- 1                   1.     A temperature-compensated, micromechanical resonator  
2 device comprising:  
3                   a substrate;  
4                   a flexural-mode resonator having first and second ends; and  
5                   a temperature-compensating support structure separate from the  
6 resonator and anchored to the substrate to support the resonator at the first and  
7 second ends above the substrate wherein both the resonator and a support structure  
8 are dimensioned and positioned relative to one another so that the resonator has  
9 enhanced thermal stability.
- 1                   2.     The device as claimed in claim 1 further comprising a drive  
2 electrode structure formed on the substrate at a position to allow electrostatic  
3 excitation of the resonator wherein the resonator and the drive electrode structure  
4 define a first gap therebetween.
- 1                   3.     The device as claimed in claim 2 wherein the first gap is a  
2 submicron lateral capacitive gap.
- 1                   4.     The device as claimed in claim 2 further comprising a sense  
2 electrode structure formed on the substrate at a position to sense output current  
3 based on motion of the resonator wherein the resonator and the sense electrode  
4 define a second gap therebetween.
- 1                   5.     The device as claimed in claim 4 wherein the second gap is  
2 a submicron lateral capacitive gap.
- 1                   6.     The device as claimed in claim 1 wherein the resonator is a  
2 single resonator beam.
- 1                   7.     The device as claimed in claim 1 wherein the support  
2 structure includes an anchor for rigidly anchoring the first end of the resonator to

3 the substrate and a folding truss support structure for substantially decoupling the  
4 second end of the resonator from the substrate.

1 8. The device as claimed in claim 1 wherein the resonator is a  
2 lateral resonator and wherein the support structure includes a pair of stress  
3 generating support members dimensioned relative to the resonator so that the  
4 resonator has enhanced thermal stability.

1 9. The device as claimed in claim 1 wherein the resonator is a  
2 polysilicon resonator.

1 10. The device as claimed in claim 9 wherein the resonator is a  
2 polysilicon resonator beam.

1 11. The device as claimed in claim 4 wherein the electrode  
2 structures are metal.

1 12. The device as claimed in claim 11 wherein the electrode  
2 structures include plated metal electrodes.

1 13. The device as claimed in claim 1 wherein the substrate is a  
2 semiconductor substrate.

1 14. The device as claimed in claim 14 wherein the semiconductor  
2 substrate is a silicon substrate.

1 15. The device as claimed in claim 1 wherein the support  
2 structure does not substantially vibrate during vibration of the resonator.

1 16. The device as claimed in claim 1 wherein energy losses to the  
2 substrate are substantially reduced to allow higher resonator device  $Q$ .

1                   17.    The device as claimed in claim 8 wherein the support  
2   members are rigid against lateral motions.

1                   18.    The device as claimed in claim 7 wherein the anchor is an off-  
2   axis anchor.

1                   19.    The device as claimed in claim 1 wherein the device is a  
2   temperature sensor.

1                   20.    A micromechanical resonator device having a frequency  
2   versus temperature curve, the device comprising:  
3                   a substrate;  
4                   a flexural-mode resonator having first and second ends; and  
5                   a support structure separate from the resonator and anchored to the  
6   substrate to support the resonator at the first and second ends above the substrate  
7   wherein both the resonator and a support structure are dimensioned and positioned  
8   relative to one another so that the frequency versus temperature curve is specifically  
9   tailored.

1                   21.    The device as claimed in claim 20 wherein the frequency  
2   versus temperature curve is designed to increase temperature dependance of the  
3   resonator.

1                   22.    The device as claimed in claim 20 wherein the frequency  
2   versus temperature curve is designed to have peaks and valleys in predefined  
3   locations.

1                   23.    A micromechanical resonator device comprising:  
2                   a substrate;  
3                   a flexural-mode resonator having first and second ends; and  
4                   a support structure separate from the resonator and anchored to the  
5   substrate to support the resonator at the first and second ends above the substrate  
6   wherein both the resonator and a support structure are dimensioned and positioned

- 7 relative to one another so that the device has a substantially zero temperature
- 8 coefficient temperature at which the device may be biased.